

Experiment No.: 03

Aim: Create a Cryptocurrency using Python and perform mining in the Blockchain created.

Task to be performed :

1. Download the code from folder, [Lab 3](#)
2. Install requests in the virtual environment created in the Lab 2. ([Follow the instructions](#))
3. Run the files - **hadcoin_node_5001.py**, **hadcoin_node_5002.py**, **hadcoin_node_5003.py** in 3 different terminals.
4. Open Postman, from each node - invoke **connect_node()** and pass the peers as POST requests.
5. Perform the following functions
 - Add Transactions - invoke **add_transactions()** as a POST request.
 - mining - **mine_block()**,
 - fetch the chain - **get_chain()**,
 - replace the longest chain - **replace_chain()**
6. Modify the code such that transactions are removed after they are added to the block.

Theory :

A blockchain is a decentralized digital ledger that records transactions in a secure and immutable manner. In a peer-to-peer (P2P) network, multiple nodes communicate directly with each other without relying on a central authority. Each node maintains its own copy of the blockchain and participates in validating and propagating transactions. However, P2P networks face several challenges such as security threats, double spending, network delays, and scalability issues. Since there is no central controller, the system must ensure that malicious nodes cannot corrupt the network. Blockchain technology addresses these challenges through cryptographic hashing, consensus mechanisms, and distributed validation.

In a blockchain network, transactions represent the transfer of digital currency from one user to another. When a transaction is created, it is broadcast to all nodes in the network. Each node verifies the transaction before accepting it. Valid transactions are temporarily stored in a memory pool (mempool).

Mining in blockchain :

Mining is the process of validating transactions and adding them to the blockchain by creating a new block. It involves solving a computational puzzle known as Proof of Work. The miner must find a valid proof that satisfies specific conditions defined by the hashing algorithm. Once the correct proof is found, a new block is created, linked to the previous block using a cryptographic

hash, and added to the chain. Mining ensures security, prevents tampering, and maintains the integrity of the blockchain. As an incentive, the miner receives a mining reward, which is a predefined amount of cryptocurrency added as a special transaction in the new block.

Steps in Mining

1. Collect transactions from the mempool.
2. Solve a mathematical puzzle.
3. Generate a valid proof.
4. Create a new block.
5. Add the block to the blockchain.

Purpose of Mining

- Validate transactions.
- Secure the network.
- Prevent double spending.
- Maintain decentralization.

Multinode blockchain network :

A multinode blockchain network consists of multiple independent nodes running simultaneously. Each node maintains its own copy of the blockchain and communicates with other nodes through HTTP requests. In this experiment, three nodes were executed on different ports to simulate decentralization. These nodes were connected so that they could share blockchain data and maintain synchronization. This setup demonstrates how decentralized systems operate without a central server. A multinode network contains multiple independent blockchain nodes.

Characteristics

- Each node has:
 - Its own blockchain copy.
 - Its own mempool.
- Nodes communicate using HTTP requests.

In the Experiment

- Three nodes were created:
 - Node 1 (port 5001)
 - Node 2 (port 5002)
 - Node 3 (port 5003)

Advantages

- Decentralization
- Fault tolerance
- Increased security
- No single point of failure

Consensus mechanism :

To ensure that all nodes agree on a single version of the blockchain, a consensus mechanism is used. In this implementation, the Longest Chain Rule is applied. According to this rule, if a node discovers another chain that is longer and valid, it replaces its own chain with the longer one. This process is known as chain replacement. The longest chain is considered the valid chain because it represents the most computational work done through mining. This mechanism resolves conflicts and maintains consistency across the network. Consensus is the process by which nodes agree on the correct blockchain.

Longest Chain Rule

In this experiment:

- Each node checks other nodes' chains.
- The node adopts the longest valid chain.

Why Longest Chain?

- It represents the most computational work.
- Harder for attackers to fake.

Transactions and Mining Reward :

Transactions represent the transfer of cryptocurrency between users. Each transaction contains the sender's address, the receiver's address, and the amount transferred. These transactions are collected by miners and added to new blocks. To encourage miners to participate in the network, a mining reward is provided. When a miner successfully mines a block, a special transaction is added to the block that grants the miner a certain amount of cryptocurrency as a reward.

Chain replacement :

Chain replacement is a process used to maintain consistency across the network. Each node periodically checks the chains of other nodes in the network. If it finds a longer and valid chain, it replaces its own chain with the longer one. This ensures that all nodes eventually agree on the same version of the blockchain. The longest chain is considered the valid one because it represents the most computational work done by the network. Chain replacement ensures all nodes follow the same blockchain.

Process

1. Node checks chains of connected nodes.
2. Finds the longest valid chain.
3. If another node has a longer chain:
 - Replace current chain.
4. If not:
 - Keep current chain.

Purpose

- Resolve conflicts between nodes.
- Maintain a single global blockchain.

Programs And Outputs :

Code :

Hadcoin_node_5001.py

```
# Module 2 - Create a Cryptocurrency
# To be installed:
# Flask==0.12.2: pip install Flask==0.12.2
# Postman HTTP Client: https://www.getpostman.com/
# requests==2.18.4: pip install requests==2.18.4

# Importing the libraries
import datetime
import hashlib
import json
from flask import Flask, jsonify, request
import requests
from uuid import uuid4
from urllib.parse import urlparse
# Generate a unique id that is in hex
# To parse url of the nodes

# Part 1 - Building a Blockchain

class Blockchain:

    def __init__(self):
        self.chain = []
        self.transactions = [] # Adding transactions before they are added to a block
        self.create_block(proof = 1, previous_hash = '0')
        self.nodes = set() # Set is used as there is no order to be maintained as the
nodes can be from all around the globe

    def create_block(self, proof, previous_hash):
        block = {'index': len(self.chain) + 1,
                 'timestamp': str(datetime.datetime.now()),
                 'proof': proof,
                 'previous_hash': previous_hash,
```

```

'transactions': self.transactions} # Adding transactions to make the blockchain a
cryptocurrency
    self.transactions = [] # The list of transaction should become empty after they
are added to a block
    self.chain.append(block)
    return block

def get_previous_block(self):
    return self.chain[-1]

def proof_of_work(self, previous_proof):
    new_proof = 1
    check_proof = False
    while check_proof is False:
        hash_operation = hashlib.sha256(str(new_proof**2 - previous_proof**2).encode()).hexdigest()
        if hash_operation[:4] == '0000':
            check_proof = True
        else:
            new_proof += 1
    return new_proof

def hash(self, block):
    encoded_block = json.dumps(block, sort_keys = True).encode()
    return hashlib.sha256(encoded_block).hexdigest()

def is_chain_valid(self, chain):
    previous_block = chain[0]
    block_index = 1
    while block_index < len(chain):
        block = chain[block_index]
        if block['previous_hash'] != self.hash(previous_block):
            return False
        previous_proof = previous_block['proof']
        proof = block['proof']
        hash_operation = hashlib.sha256(str(proof**2 - previous_proof**2).encode()).hexdigest()
        if hash_operation[:4] != '0000':
            return False
        previous_block = block
        block_index += 1
    return True

```

```

# This method will add the transaction to the list of transactions
def add_transaction(self, sender, receiver, amount):
    self.transactions.append({'sender': sender,
                             'receiver': receiver,
                             'amount': amount})
    previous_block = self.get_previous_block()
    return previous_block['index'] + 1                                # It will return the block index to which the
transaction should be added

# This function will add the node containing an address to the set of nodes created in init function
def add_node(self, address):
    parsed_url = urlparse(address)                                     # urlparse will parse the url from the address
    self.nodes.add(parsed_url.netloc)                                    # Add is used and not append as it's a set. Netloc will
only return '127.0.0.1:5000'

# Consensus Protocol. This function will replace all the shorter chain with the longer chain in all the nodes on the
network
def replace_chain(self):
    network = self.nodes                                         # network variable is the set of nodes all around the globe
    longest_chain = None                                         # It will hold the longest chain when we scan the
network
    max_length = len(self.chain)                                    # This will hold the length of the chain held by the
node that runs this function
    for node in network:
        response = requests.get(f'http://{node}/get_chain')          # Use get_chain method already created to get
the length of the chain
        if response.status_code == 200:
            length = response.json()['length']                      # Extract the length of the chain from get_chain
function
            chain = response.json()['chain']
            if length > max_length and self.is_chain_valid(chain):    # We check if the length is bigger and if the
chain is valid then
                max_length = length                                  # We update the max length
                longest_chain = chain                               # We update the longest chain
            if longest_chain:                                       # If longest_chain is not none that means it was replaced
                self.chain = longest_chain                         # Replace the chain of the current node with the longest
chain
            return True
        return False                                              # Return false if current chain is the longest one

# Part 2 - Mining our Blockchain

```

```

# Creating a Web App
app = Flask(__name__)

# Creating an address for the node on Port 5000. We will create some other nodes as well on different ports
node_address = str(uuid4()).replace('-', '') #


# Creating a Blockchain
blockchain = Blockchain()

# Mining a new block
@app.route('/mine_block', methods = ['GET'])
def mine_block():
    previous_block = blockchain.get_previous_block()
    previous_proof = previous_block['proof']
    proof = blockchain.proof_of_work(previous_proof)
    previous_hash = blockchain.hash(previous_block)

    blockchain.add_transaction(sender = node_address, receiver = 'Richard', amount = 1) # Hadcoins to mine the
block (A Reward). So the node gives 1 hadcoin to Abcde for mining the block

    block = blockchain.create_block(proof, previous_hash)
    response = {'message': 'Congratulations, you just mined a block!', 'index': block['index'],
'timestamp': block['timestamp'], 'proof': block['proof'], 'previous_hash': block['previous_hash'],
'transactions': block['transactions']}
    return jsonify(response), 200

# Getting the full Blockchain
@app.route('/get_chain', methods = ['GET'])
def get_chain():
    response = {'chain': blockchain.chain, 'length': len(blockchain.chain)}
    return jsonify(response), 200

# Checking if the Blockchain is valid
@app.route('/is_valid', methods = ['GET'])
def is_valid():
    is_valid = blockchain.is_chain_valid(blockchain.chain)
    if is_valid:
        response = {'message': 'All good. The Blockchain is valid.'}
    else:
        response = {'message': 'The Blockchain is not valid.'}
    return jsonify(response), 200

```

```

else:
    response = {'message': 'Houston, we have a problem. The Blockchain is not valid.'}
    return jsonify(response), 200

# Adding a new transaction to the Blockchain
@app.route('/add_transaction', methods = ['POST'])          # Post method as we have to pass something
to get something in return
def add_transaction():
    json = request.get_json()                            # This will get the json file from postman. In Postman we
will create a json file in which we will pass the values for the keys in the json file
    transaction_keys = ['sender', 'receiver', 'amount']
    if not all(key in json for key in transaction_keys):   # Checking if all keys are available in json
        return 'Some elements of the transaction are missing', 400
    index = blockchain.add_transaction(json['sender'], json['receiver'], json['amount'])
    response = {'message': f'This transaction will be added to Block {index}'}
    return jsonify(response), 201                         # Code 201 for creation

# Part 3 - Decentralizing our Blockchain

# Connecting new nodes
@app.route('/connect_node', methods = ['POST'])           # POST request to register the new nodes
from the json file
def connect_node():
    json = request.get_json()
    nodes = json.get('nodes')                           # Get the nodes from json file
    if nodes is None:
        return "No node", 400
    for node in nodes:
        blockchain.add_node(node)
    response = {'message': 'All the nodes are now connected. The Hadcoin Blockchain now contains the following
nodes:',
                'total_nodes': list(blockchain.nodes)}
    return jsonify(response), 201

# Replacing the chain by the longest chain if needed
@app.route('/replace_chain', methods = ['GET'])
def replace_chain():
    is_chain_replaced = blockchain.replace_chain()
    if is_chain_replaced:
        response = {'message': 'The nodes had different chains so the chain was replaced by the longest one.',
                    'new_chain': blockchain.chain}

```

```

else:
    response = {'message': 'All good. The chain is the largest one',
                'actual_chain': blockchain.chain}
return jsonify(response), 200

# Running the app
app.run(host = '0.0.0.0', port = 5001)

```

Hadcoin_node_5002.py

```

# Module 2 - Create a Cryptocurrency
# To be installed:
# Flask==0.12.2: pip install Flask==0.12.2
# Postman HTTP Client: https://www.getpostman.com/
# requests==2.18.4: pip install requests==2.18.4

# Importing the libraries
import datetime
import hashlib
import json
from flask import Flask, jsonify, request
import requests
from uuid import uuid4
from urllib.parse import urlparse
                                # Generate a unique id that is in hex
                                # To parse url of the nodes

# Part 1 - Building a Blockchain

class Blockchain:

    def __init__(self):
        self.chain = []
        self.transactions = []          # Adding transactions before they are added to a block
        self.create_block(proof = 1, previous_hash = '0')
        self.nodes = set()              # Set is used as there is no order to be maintained as the
                                        # nodes can be from all around the globe

    def create_block(self, proof, previous_hash):
        block = {'index': len(self.chain) + 1,
                 'timestamp': str(datetime.datetime.now()),
                 'proof': proof,
                 'previous_hash': previous_hash,
                 'transactions': self.transactions}          # Adding transactions to make the blockchain a

```

```

cryptocurrency
    self.transactions = []                                # The list of transaction should become empty after they
are added to a block
    self.chain.append(block)
    return block

def get_previous_block(self):
    return self.chain[-1]

def proof_of_work(self, previous_proof):
    new_proof = 1
    check_proof = False
    while check_proof is False:
        hash_operation = hashlib.sha256(str(new_proof**2 - previous_proof**2).encode()).hexdigest()
        if hash_operation[:4] == '0000':
            check_proof = True
        else:
            new_proof += 1
    return new_proof

def hash(self, block):
    encoded_block = json.dumps(block, sort_keys = True).encode()
    return hashlib.sha256(encoded_block).hexdigest()

def is_chain_valid(self, chain):
    previous_block = chain[0]
    block_index = 1
    while block_index < len(chain):
        block = chain[block_index]
        if block['previous_hash'] != self.hash(previous_block):
            return False
        previous_proof = previous_block['proof']
        proof = block['proof']
        hash_operation = hashlib.sha256(str(proof**2 - previous_proof**2).encode()).hexdigest()
        if hash_operation[:4] != '0000':
            return False
        previous_block = block
        block_index += 1
    return True

# This method will add the transaction to the list of transactions

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```

def add_transaction(self, sender, receiver, amount):
    self.transactions.append({'sender': sender,
                             'receiver': receiver,
                             'amount': amount})
previous_block = self.get_previous_block()
return previous_block['index'] + 1                                # It will return the block index to which the
transaction should be added

# This function will add the node containing an address to the set of nodes created in init function
def add_node(self, address):
    parsed_url = urlparse(address)                               # urlparse will parse the url from the address
    self.nodes.add(parsed_url.netloc)                            # Add is used and not append as it's a set. Netloc will
only return '127.0.0.1:5000'

# Consensus Protocol. This function will replace all the shorter chain with the longer chain in all the nodes on the
network
def replace_chain(self):
    network = self.nodes                                       # network variable is the set of nodes all around the globe
    longest_chain = None                                       # It will hold the longest chain when we scan the
network
    max_length = len(self.chain)                                # This will hold the length of the chain held by the
node that runs this function
    for node in network:
        response = requests.get(f'http://{node}/get_chain')      # Use get_chain method already created to get
the length of the chain
        if response.status_code == 200:
            length = response.json()['length']                  # Extract the length of the chain from get_chain
function
            chain = response.json()['chain']
            if length > max_length and self.is_chain_valid(chain):    # We check if the length is bigger and if the
chain is valid then
                max_length = length                                # We update the max length
                longest_chain = chain                             # We update the longest chain
            if longest_chain:
                self.chain = longest_chain                      # If longest_chain is not none that means it was replaced
                # Replace the chain of the current node with the longest
chain
            return True
        return False                                         # Return false if current chain is the longest one

# Part 2 - Mining our Blockchain

```

```

# Creating a Web App
app = Flask(__name__)

# Creating an address for the node on Port 5000. We will create some other nodes as well on different ports
node_address = str(uuid4()).replace('-', '') # 

# Creating a Blockchain
blockchain = Blockchain()

# Mining a new block
@app.route('/mine_block', methods=['GET'])
def mine_block():
    previous_block = blockchain.get_previous_block()
    previous_proof = previous_block['proof']
    proof = blockchain.proof_of_work(previous_proof)
    previous_hash = blockchain.hash(previous_block)
    blockchain.add_transaction(sender = node_address, receiver = 'you', amount = 1) # Hadcoins to mine the block (A Reward). So the node gives 1 hadcoin to Abcde for mining the block
    block = blockchain.create_block(proof, previous_hash)
    response = {'message': 'Congratulations, you just mined a block!', 
                'index': block['index'],
                'timestamp': block['timestamp'],
                'proof': block['proof'],
                'previous_hash': block['previous_hash'],
                'transactions': block['transactions']}
    return jsonify(response), 200

# Getting the full Blockchain
@app.route('/get_chain', methods=['GET'])
def get_chain():
    response = {'chain': blockchain.chain,
                'length': len(blockchain.chain)}
    return jsonify(response), 200

# Checking if the Blockchain is valid
@app.route('/is_valid', methods=['GET'])
def is_valid():
    is_valid = blockchain.is_chain_valid(blockchain.chain)
    if is_valid:
        response = {'message': 'All good. The Blockchain is valid.'}
    else:
        response = {'message': 'The Blockchain is not valid.'}
    return jsonify(response), 200

```

```

response = {'message': 'Houston, we have a problem. The Blockchain is not valid.'}
return jsonify(response), 200

# Adding a new transaction to the Blockchain
@app.route('/add_transaction', methods = ['POST'])          # Post method as we have to pass something
to get something in return
def add_transaction():
    json = request.get_json()                         # This will get the json file from postman. In Postman we
will create a json file in which we will pass the values for the keys in the json file
    transaction_keys = ['sender', 'receiver', 'amount']
    if not all(key in json for key in transaction_keys):      # Checking if all keys are available in json
        return 'Some elements of the transaction are missing', 400
    index = blockchain.add_transaction(json['sender'], json['receiver'], json['amount'])
    response = {'message': f'This transaction will be added to Block {index}'}
    return jsonify(response), 201                         # Code 201 for creation

# Part 3 - Decentralizing our Blockchain

# Connecting new nodes
@app.route('/connect_node', methods = ['POST'])          # POST request to register the new nodes
from the json file
def connect_node():
    json = request.get_json()
    nodes = json.get('nodes')                           # Get the nodes from json file
    if nodes is None:
        return "No node", 400
    for node in nodes:
        blockchain.add_node(node)
    response = {'message': 'All the nodes are now connected. The Hadcoin Blockchain now contains the following
nodes:', 'total_nodes': list(blockchain.nodes)}
    return jsonify(response), 201

# Replacing the chain by the longest chain if needed
@app.route('/replace_chain', methods = ['GET'])
def replace_chain():
    is_chain_replaced = blockchain.replace_chain()
    if is_chain_replaced:
        response = {'message': 'The nodes had different chains so the chain was replaced by the longest one.', 'new_chain': blockchain.chain}
    else:

```

```

response = {'message': 'All good. The chain is the largest one',
            'actual_chain': blockchain.chain}
return jsonify(response), 200

```

```

# Running the app
app.run(host = '0.0.0.0', port = 5002)

```

Hadcoin_node_5003.py

```

# Module 2 - Create a Cryptocurrency
# To be installed:
# Flask==0.12.2: pip install Flask==0.12.2
# Postman HTTP Client: https://www.getpostman.com/
# requests==2.18.4: pip install requests==2.18.4

```

```

# Importing the libraries
import datetime
import hashlib
import json
from flask import Flask, jsonify, request
import requests
from uuid import uuid4
from urllib.parse import urlparse

```

Generate a unique id that is in hex
To parse url of the nodes

```
# Part 1 - Building a Blockchain
```

```
class Blockchain:
```

```

def __init__(self):
    self.chain = []
    self.transactions = [] # Adding transactions before they are added to a block
    self.create_block(proof = 1, previous_hash = '0')
    self.nodes = set() # Set is used as there is no order to be maintained as the
nodes can be from all around the globe

```

```

def create_block(self, proof, previous_hash):
    block = {'index': len(self.chain) + 1,
             'timestamp': str(datetime.datetime.now()),
             'proof': proof,
             'previous_hash': previous_hash,
             'transactions': self.transactions} # Adding transactions to make the blockchain a
cryptocurrency

```

```

    self.transactions = [] # The list of transaction should become empty after they
are added to a block
    self.chain.append(block)
    return block

def get_previous_block(self):
    return self.chain[-1]

def proof_of_work(self, previous_proof):
    new_proof = 1
    check_proof = False
    while check_proof is False:
        hash_operation = hashlib.sha256(str(new_proof**2 - previous_proof**2).encode()).hexdigest()
        if hash_operation[:4] == '0000':
            check_proof = True
        else:
            new_proof += 1
    return new_proof

def hash(self, block):
    encoded_block = json.dumps(block, sort_keys = True).encode()
    return hashlib.sha256(encoded_block).hexdigest()

def is_chain_valid(self, chain):
    previous_block = chain[0]
    block_index = 1
    while block_index < len(chain):
        block = chain[block_index]
        if block['previous_hash'] != self.hash(previous_block):
            return False
        previous_proof = previous_block['proof']
        proof = block['proof']
        hash_operation = hashlib.sha256(str(proof**2 - previous_proof**2).encode()).hexdigest()
        if hash_operation[:4] != '0000':
            return False
        previous_block = block
        block_index += 1
    return True

# This method will add the transaction to the list of transactions
def add_transaction(self, sender, receiver, amount):

```

```

    self.transactions.append({'sender': sender,
        'receiver': receiver,
        'amount': amount})
    previous_block = self.get_previous_block()
    return previous_block['index'] + 1                                # It will return the block index to which the
transaction should be added

# This function will add the node containing an address to the set of nodes created in init function
def add_node(self, address):
    parsed_url = urlparse(address)                                # urlparse will parse the url from the address
    self.nodes.add(parsed_url.netloc)                             # Add is used and not append as it's a set. Netloc will
only return '127.0.0.1:5000'

# Consensus Protocol. This function will replace all the shorter chain with the longer chain in all the nodes on the
network
def replace_chain(self):
    network = self.nodes                                         # network variable is the set of nodes all around the globe
    longest_chain = None                                         # It will hold the longest chain when we scan the
network
    max_length = len(self.chain)                                 # This will hold the length of the chain held by the
node that runs this function
    for node in network:
        response = requests.get(f'http://{node}/get_chain')      # Use get_chain method already created to get
the length of the chain
        if response.status_code == 200:
            length = response.json()['length']                  # Extract the length of the chain from get_chain
function
            chain = response.json()['chain']
            if length > max_length and self.is_chain_valid(chain): # We check if the length is bigger and if the
chain is valid then
                max_length = length                            # We update the max length
                longest_chain = chain                          # We update the longest chain
            if longest_chain:                                # If longest_chain is not none that means it was replaced
                self.chain = longest_chain                   # Replace the chain of the current node with the longest
chain
            return True
        return False                                         # Return false if current chain is the longest one

# Part 2 - Mining our Blockchain

# Creating a Web App

```

```

app = Flask(__name__)

# Creating an address for the node on Port 5000. We will create some other nodes as well on different ports
node_address = str(uuid4()).replace('-', '') # 

# Creating a Blockchain
blockchain = Blockchain()

# Mining a new block
@app.route('/mine_block', methods = ['GET'])
def mine_block():
    previous_block = blockchain.get_previous_block()
    previous_proof = previous_block['proof']
    proof = blockchain.proof_of_work(previous_proof)
    previous_hash = blockchain.hash(previous_block)
    blockchain.add_transaction(sender = node_address, receiver = 'Abcde', amount = 1) # Hadcoins to mine the block
(A Reward). So the node gives 1 hadcoin to Abcde for mining the block
    block = blockchain.create_block(proof, previous_hash)
    response = {'message': 'Congratulations, you just mined a block!', 
                'index': block['index'],
                'timestamp': block['timestamp'],
                'proof': block['proof'],
                'previous_hash': block['previous_hash'],
                'transactions': block['transactions']}
    return jsonify(response), 200

# Getting the full Blockchain
@app.route('/get_chain', methods = ['GET'])
def get_chain():
    response = {'chain': blockchain.chain,
                'length': len(blockchain.chain)}
    return jsonify(response), 200

# Checking if the Blockchain is valid
@app.route('/is_valid', methods = ['GET'])
def is_valid():
    is_valid = blockchain.is_chain_valid(blockchain.chain)
    if is_valid:
        response = {'message': 'All good. The Blockchain is valid.'}
    else:
        response = {'message': 'Houston, we have a problem. The Blockchain is not valid.'}
    return jsonify(response), 200

```

```

return jsonify(response), 200

# Adding a new transaction to the Blockchain
@app.route('/add_transaction', methods = ['POST']) # Post method as we have to pass something
to get something in return
def add_transaction():
    json = request.get_json() # This will get the json file from postman. In Postman we
will create a json file in which we will pass the values for the keys in the json file
    transaction_keys = ['sender', 'receiver', 'amount']
    if not all(key in json for key in transaction_keys): # Checking if all keys are available in json
        return 'Some elements of the transaction are missing', 400
    index = blockchain.add_transaction(json['sender'], json['receiver'], json['amount'])
    response = {'message': f'This transaction will be added to Block {index}'}
    return jsonify(response), 201 # Code 201 for creation

# Part 3 - Decentralizing our Blockchain

# Connecting new nodes
@app.route('/connect_node', methods = ['POST']) # POST request to register the new nodes
from the json file
def connect_node():
    json = request.get_json()
    nodes = json.get('nodes') # Get the nodes from json file
    if nodes is None:
        return "No node", 400
    for node in nodes:
        blockchain.add_node(node)
    response = {'message': 'All the nodes are now connected. The Hadcoin Blockchain now contains the following
nodes:', 'total_nodes': list(blockchain.nodes)}
    return jsonify(response), 201

# Replacing the chain by the longest chain if needed
@app.route('/replace_chain', methods = ['GET'])
def replace_chain():
    is_chain_replaced = blockchain.replace_chain()
    if is_chain_replaced:
        response = {'message': 'The nodes had different chains so the chain was replaced by the longest one.',
        'new_chain': blockchain.chain}
    else:
        response = {'message': 'All good. The chain is the largest one.'}

```

```
'actual_chain': blockchain.chain}

return jsonify(response), 200

# Running the app
app.run(host = '0.0.0.0', port = 5003)
```

Nodes.json

```
{
  "nodes": ["http://127.0.0.1:5001",
            "http://127.0.0.1:5002",
            "http://127.0.0.1:5003"]}
```

Transaction.json

```
{
  "sender": "",
  "receiver": "",
  "amount": }
```

Output :

After installing all the required libraries run three of the files from three different terminals. It will act as three different nodes.

```
hadcoin_node_5001.py
hadcoin_node_5002.py
hadcoin_node_5003.py

POSTMAN... Exp_3 hadcoin_node_5001.py http://127.0.0.1:5001 ... hadcoin_node_5002.py http://127.0.0.1:5002 ... hadcoin_node_5003.py http://127.0.0.1:5003 ... CHAT SESSIONS

New HTTP Request
My Workspace
+ Filter
OpenTable API Docum...
Restaurant Listing Api

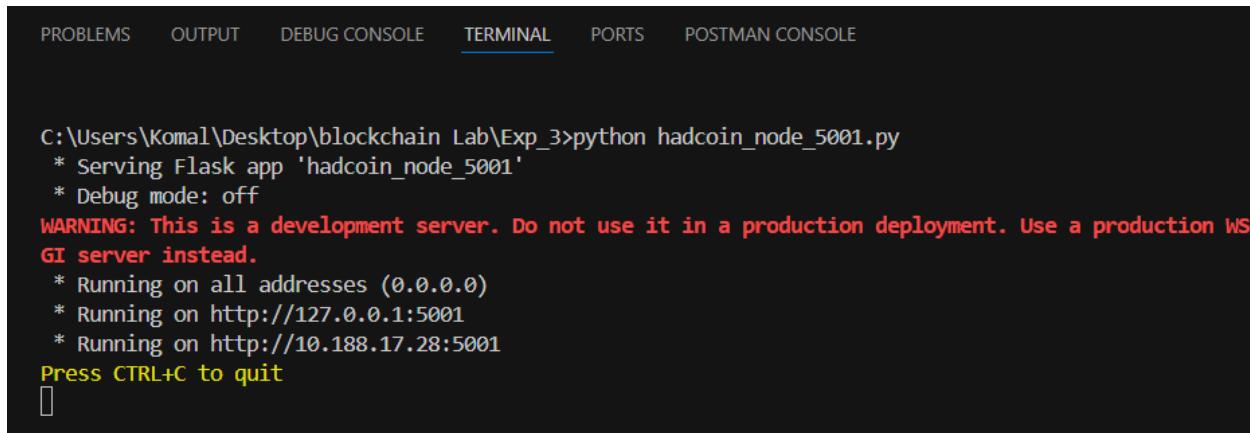
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS POSTMAN CONSOLE
+ v ... | x

C:\Users\Komal\Desktop\Blockchain Lab\Exp_3>python hadcoin_node_5001.py
C:\Users\Komal\Desktop\Blockchain Lab\Exp_3>python hadcoin_node_5002.py
C:\Users\Komal\Desktop\Blockchain Lab\Exp_3>python hadcoin_node_5003.py
  * Serving Flask app 'hadcoin_node_5001'
  * Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
  * Running on all addresses (0.0.0.0)
  * Running on 127.0.0.1:5001
  * Running on http://127.0.0.1:5001
  * Running on http://18.188.17.28:5001
Press CTRL+C to quit
127.0.0.1 - - [12/Feb/2026 23:33:08] "GET /connect_node HTTP/1.1" 405 -
127.0.0.1 - - [12/Feb/2026 23:33:22] "POST /connect_node HTTP/1.1" 201 -
```

```
Press CTRL+C to quit
127.0.0.1 - - [12/Feb/2026 23:33:08] "GET /connect_node HTTP/1.1" 405 -
127.0.0.1 - - [12/Feb/2026 23:33:22] "POST /connect_node HTTP/1.1" 201 -
```

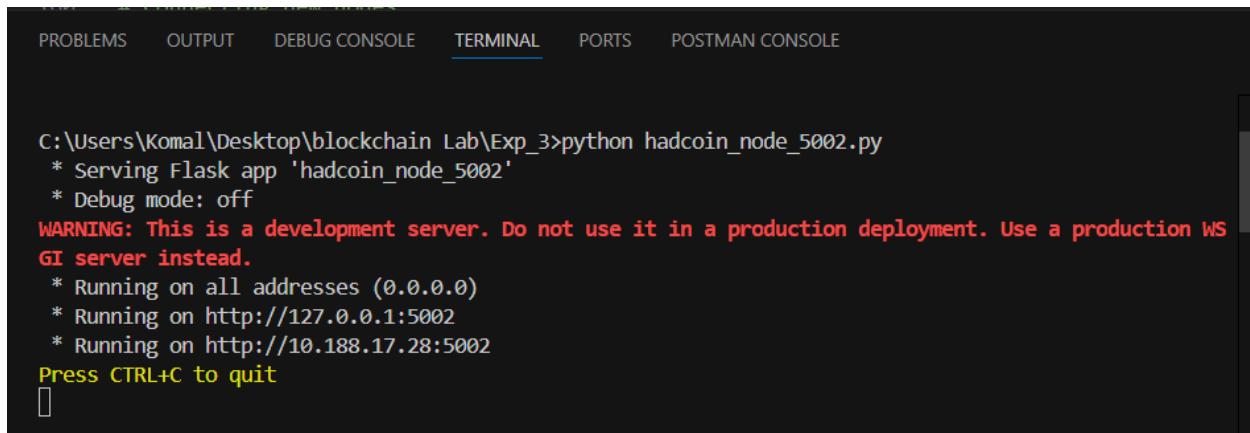
```
Press CTRL+C to quit
```

```
Ln 186, Col 39 Spaces: 4 UFT-8 CRLF {} Python 3.10.0 Go Live
25°C Clear Search
2/12/2026 11:49 PM ENG IN
```



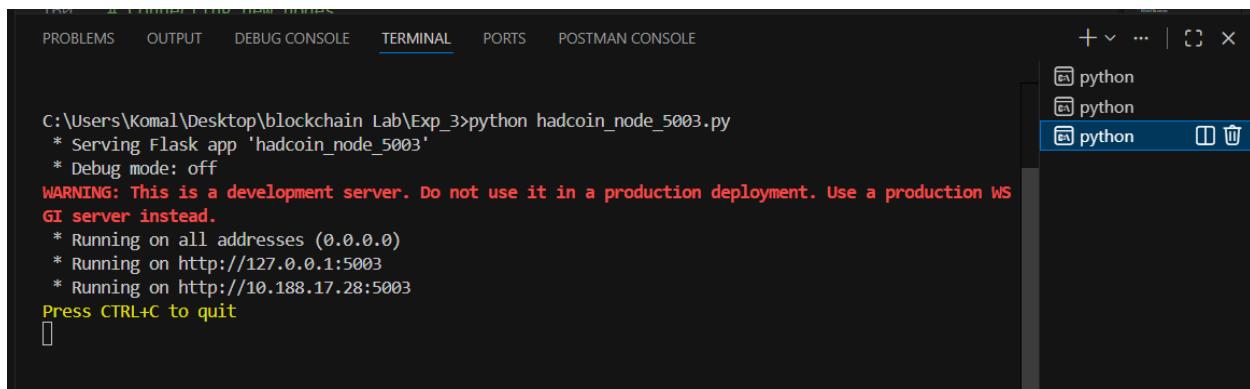
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS POSTMAN CONSOLE

```
C:\Users\Komal\Desktop\blockchain Lab\Exp_3>python hadcoin_node_5001.py
* Serving Flask app 'hadcoin_node_5001'
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WS GI server instead.
* Running on all addresses (0.0.0.0)
* Running on http://127.0.0.1:5001
* Running on http://10.188.17.28:5001
Press CTRL+C to quit
```



PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS POSTMAN CONSOLE

```
C:\Users\Komal\Desktop\blockchain Lab\Exp_3>python hadcoin_node_5002.py
* Serving Flask app 'hadcoin_node_5002'
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WS GI server instead.
* Running on all addresses (0.0.0.0)
* Running on http://127.0.0.1:5002
* Running on http://10.188.17.28:5002
Press CTRL+C to quit
```



PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS POSTMAN CONSOLE

```
C:\Users\Komal\Desktop\blockchain Lab\Exp_3>python hadcoin_node_5003.py
* Serving Flask app 'hadcoin_node_5003'
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WS GI server instead.
* Running on all addresses (0.0.0.0)
* Running on http://127.0.0.1:5003
* Running on http://10.188.17.28:5003
Press CTRL+C to quit
```

+ × ⋮ | [] ×

- python
- python
- python

Open Postman and then

Connect the Nodes (Each node must know about the others) by doing POST request on connect_node by providing other two end point as body

http://127.0.0.1:5001/connect_node

POST http://127.0.0.1:5001/connect_node

Save | No Environment | Send | **Body**

Params Authorization Headers (9) Body Scripts Settings

none form-data x-www-form-urlencoded raw binary GraphQL JSON

```

1 {
2   "nodes": [
3     "http://127.0.0.1:5002",
4     "http://127.0.0.1:5003"
5   ]
6 }
7

```

Code Cookies Beautify

Body Cookies Headers (5) Test Results

Status: 201 Created Time: 13 ms Size: 325 B

Pretty Raw Preview JSON

```

1 [
2   "message": "All the nodes are now connected. The Hadcoin Blockchain now contains the following nodes:",
3   "total_nodes": [
4     "127.0.0.1:5002",
5     "127.0.0.1:5003"
6   ]
7 ]

```

http://127.0.0.1:5002/connect_node

POST http://127.0.0.1:5002/connect_node

Save | No Environment | Send | **Body**

Params Authorization Headers (9) Body Scripts Settings

none form-data x-www-form-urlencoded raw binary GraphQL JSON

```

1 {
2   "nodes": [
3     "http://127.0.0.1:5001",
4     "http://127.0.0.1:5003"
5   ]
6 }
7

```

Code Cookies Beautify

Body Cookies Headers (5) Test Results

Status: 201 Created Time: 22 ms Size: 325 B

Pretty Raw Preview JSON

```

1 [
2   "message": "All the nodes are now connected. The Hadcoin Blockchain now contains the following nodes:",
3   "total_nodes": [
4     "127.0.0.1:5001",
5     "127.0.0.1:5003"
6   ]
7 ]

```

POST http://127.0.0.1:5003/connect_node

Body (raw JSON)

```
{
  "nodes": [
    "http://127.0.0.1:5001",
    "http://127.0.0.1:5002"
  ]
}
```

Status: 201 Created Time: 19 ms Size: 325 B

```
[
  {
    "message": "All the nodes are now connected. The Hadcoin Blockchain now contains the following nodes:",
    "total_nodes": [
      "127.0.0.1:5001",
      "127.0.0.1:5002"
    ]
  }
]
```

Add transactions from one of the node (I added in node 2)

GET http://127.0.0.1:5002/get_chain

Body

```
This request does not have a body
```

Status: 200 OK Time: 11 ms Size: 290 B

```
[
  {
    "chain": [
      {
        "index": 1,
        "previous_hash": "0",
        "proof": 1,
        "timestamp": "2026-02-12 23:28:41.035243",
        "transactions": []
      }
    ],
    "length": 1
  }
]
```

The screenshot shows two separate POST requests made to the endpoint `http://127.0.0.1:5002/add_transaction`.

Request 1:

```

1 {
2   "sender": "Komal",
3   "receiver": "Deolekar",
4   "amount": 250
5 }
6
7
  
```

Request 2:

```

1 {
2   "sender": "Reva",
3   "receiver": "Rohan",
4   "amount": 4400
5 }
6
7
  
```

Both requests resulted in a `201 Created` status with a response time of approximately 14 ms and a response size of 226 B.

Mine the block

The screenshot shows a GET request made to the endpoint `http://127.0.0.1:5002/mine_block`.

Request:

```

GET http://127.0.0.1:5002/mine_block
  
```

Response:

```

{
  "index": 2,
  "message": "Congratulations, you just mined a block!",
  "previous_hash": "94ab5fc372be8146b26f32430d580e5f4f439b2c9da5b6c53228524b056c7e1",
  "proof": 533,
  "timestamp": "2026-02-12 23:45:12.122866",
  "transactions": [
    {"amount": 250, "receiver": "Deolekar", "sender": "Komal"},
    {"amount": 4400, "receiver": "Rohan", "sender": "Reva"},
    {"amount": 1, "receiver": "you", "sender": "16511c858cfa48eeaba1895e32860910"}
  ]
}
  
```

The response indicates a `200 OK` status with a response time of 16 ms and a response size of 563 B.

From node 2 I added only one block so length on node 2 id 2(genesis + this block)

```

1  [{"chain": [{"index": 1, "previous_hash": "0", "proof": 1, "timestamp": "2026-02-12 23:28:41.035243", "transactions": []}, {"index": 2, "previous_hash": "04ab53fc372be8146b26f32430d580e5f4f439b2c9da5b6c53228524b056c7e1", "proof": 533, "timestamp": "2026-02-12 23:45:12.122866", "transactions": [{"amount": 250, "receiver": "Deolekar", "sender": "Komal"}, {"amount": 4400, "receiver": "Rohan", "sender": "Reva"}, {"amount": 1, "receiver": "you", "sender": "16511c858cf48eeaba1895e32860910"}]}, "length": 2}]

```

From node 3 I added 4 more blocks so that length will be 5

```

1  [{"chain": [{"index": 1, "previous_hash": "0", "proof": 1, "timestamp": "2026-02-12 23:29:06.881988", "transactions": []}, {"index": 2, "previous_hash": "04ab53fc372be8146b26f32430d580e5f4f439b2c9da5b6c53228524b056c7e1", "proof": 533, "timestamp": "2026-02-12 23:45:12.122866", "transactions": [{"amount": 250, "receiver": "Deolekar", "sender": "Komal"}, {"amount": 4400, "receiver": "Rohan", "sender": "Reva"}, {"amount": 1, "receiver": "you", "sender": "16511c858cf48eeaba1895e32860910"}]}, {"index": 3, "previous_hash": "04ab53fc372be8146b26f32430d580e5f4f439b2c9da5b6c53228524b056c7e1", "proof": 534, "timestamp": "2026-02-12 23:45:12.122866", "transactions": [{"amount": 250, "receiver": "Rohan", "sender": "Reva"}, {"amount": 1, "receiver": "you", "sender": "16511c858cf48eeaba1895e32860910"}]}, {"index": 4, "previous_hash": "04ab53fc372be8146b26f32430d580e5f4f439b2c9da5b6c53228524b056c7e1", "proof": 535, "timestamp": "2026-02-12 23:45:12.122866", "transactions": [{"amount": 250, "receiver": "you", "sender": "16511c858cf48eeaba1895e32860910"}]}, {"index": 5, "previous_hash": "04ab53fc372be8146b26f32430d580e5f4f439b2c9da5b6c53228524b056c7e1", "proof": 536, "timestamp": "2026-02-12 23:45:12.122866", "transactions": [{"amount": 250, "receiver": "16511c858cf48eeaba1895e32860910", "sender": "you"}]}, {"index": 6, "previous_hash": "04ab53fc372be8146b26f32430d580e5f4f439b2c9da5b6c53228524b056c7e1", "proof": 537, "timestamp": "2026-02-12 23:45:12.122866", "transactions": [{"amount": 250, "receiver": "you", "sender": "16511c858cf48eeaba1895e32860910"}]}], "length": 5}

```

Add transactions

```

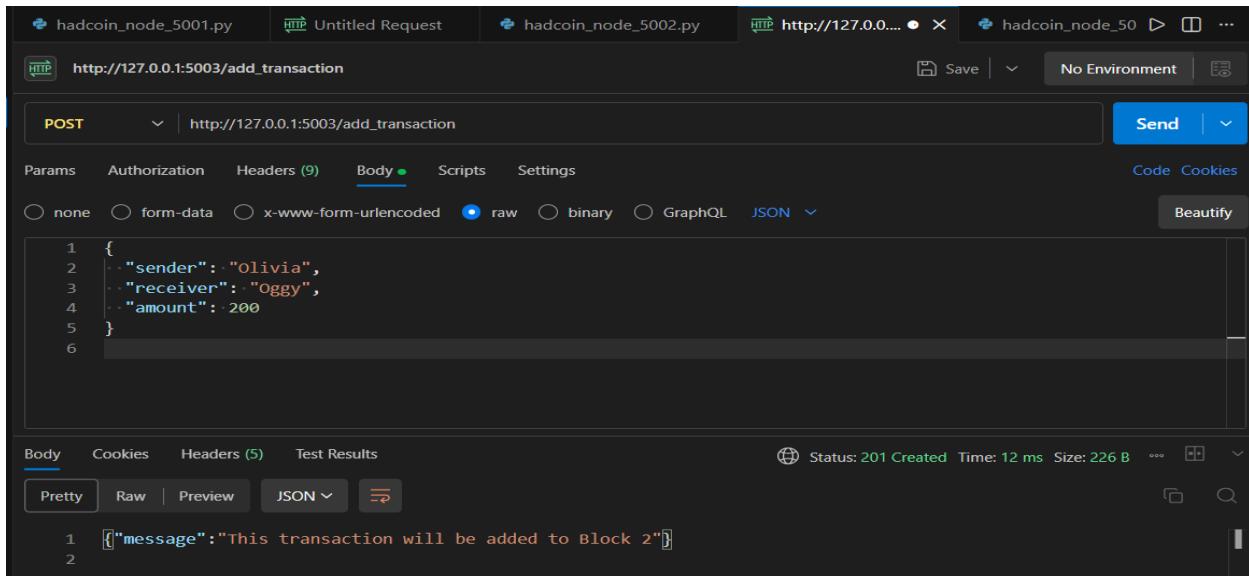
1  {
2    .. "sender": "Rama",
3    .. "receiver": "Jack",
4    .. "amount": 2400
5  }

```

```

1  {"message": "This transaction will be added to Block 2"}

```



POST http://127.0.0.1:5003/add_transaction

Body

```

1 {
2   "sender": "olivia",
3   "receiver": "Oggy",
4   "amount": 200
5 }
6

```

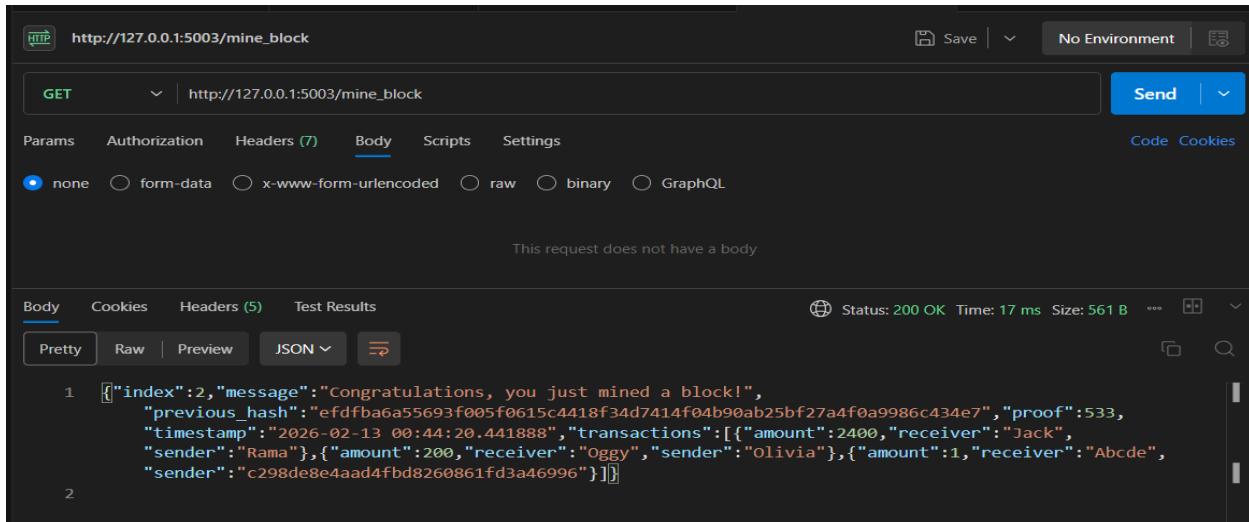
Status: 201 Created Time: 12 ms Size: 226 B

```

1 [{"message": "This transaction will be added to Block 2"}]
2

```

Mine the block



GET http://127.0.0.1:5003/mine_block

This request does not have a body

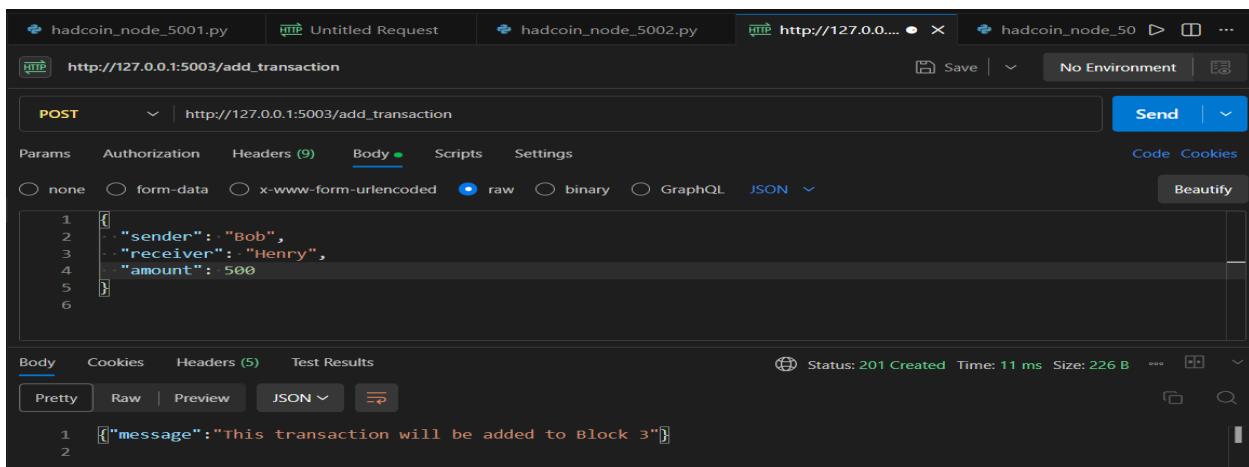
Status: 200 OK Time: 17 ms Size: 561 B

```

1 {"index":2,"message": "Congratulations, you just mined a block!", "previous_hash": "efdfba6a55693f005f0615c4418f34d7414f04b90ab25bf27a4f0a9986c434e7", "proof": 533, "timestamp": "2026-02-13 00:44:20.441888", "transactions": [{"amount": 2400, "receiver": "Jack", "sender": "Rama"}, {"amount": 200, "receiver": "Oggy", "sender": "Olivia"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fb8260861fd3a46996"}]}
2

```

Add transaction



POST http://127.0.0.1:5003/add_transaction

Body

```

1 [
2   {"sender": "Bob", "receiver": "Henry", "amount": 500}
3 ]
4
5
6

```

Status: 201 Created Time: 11 ms Size: 226 B

```

1 [{"message": "This transaction will be added to Block 3"}]
2

```

Mine the block

HTTP http://127.0.0.1:5003/mine_block

GET http://127.0.0.1:5003/mine_block

Params Authorization Headers (7) Body Scripts Settings

none form-data x-www-form-urlencoded raw binary GraphQL

This request does not have a body

Body Cookies Headers (5) Test Results

Status: 200 OK Time: 185 ms Size: 511 B

```
1  [{"message": "This transaction will be added to Block 3"}]
```

Add transaction

HTTP http://127.0.0.1:5003/add_transaction

POST http://127.0.0.1:5003/add_transaction

Params Authorization Headers (9) Body Scripts Settings

none form-data x-www-form-urlencoded raw binary GraphQL [JSON](#)

```
1  {
  2    "sender": "Robin",
  3    "receiver": "Leon",
  4    "amount": 100
  5  }
  6
```

Body Cookies Headers (5) Test Results

Status: 201 Created Time: 11 ms Size: 226 B

```
1  [{"message": "This transaction will be added to Block 4"}]
```

Mine the block

HTTP http://127.0.0.1:5003/add_transaction

POST http://127.0.0.1:5003/add_transaction

Params Authorization Headers (9) Body Scripts Settings

none form-data x-www-form-urlencoded raw binary GraphQL [JSON](#)

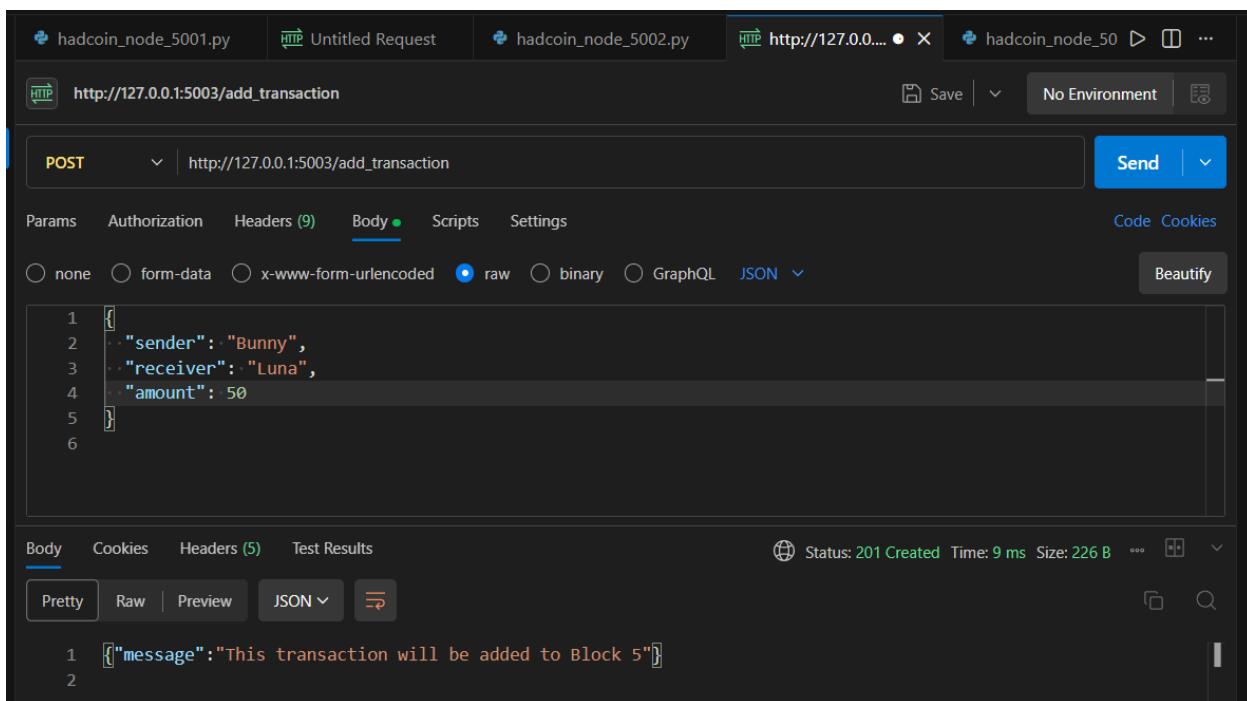
```
1  {
  2    "sender": "Aiden",
  3    "receiver": "Komal",
  4    "amount": 5500
  5  }
  6
```

Body Cookies Headers (5) Test Results

Status: 201 Created Time: 11 ms Size: 226 B

```
1  [{"message": "This transaction will be added to Block 5"}]
```

Add transaction



The screenshot shows the Postman interface with a POST request to `http://127.0.0.1:5003/add_transaction`. The request body is a JSON object representing a transaction:

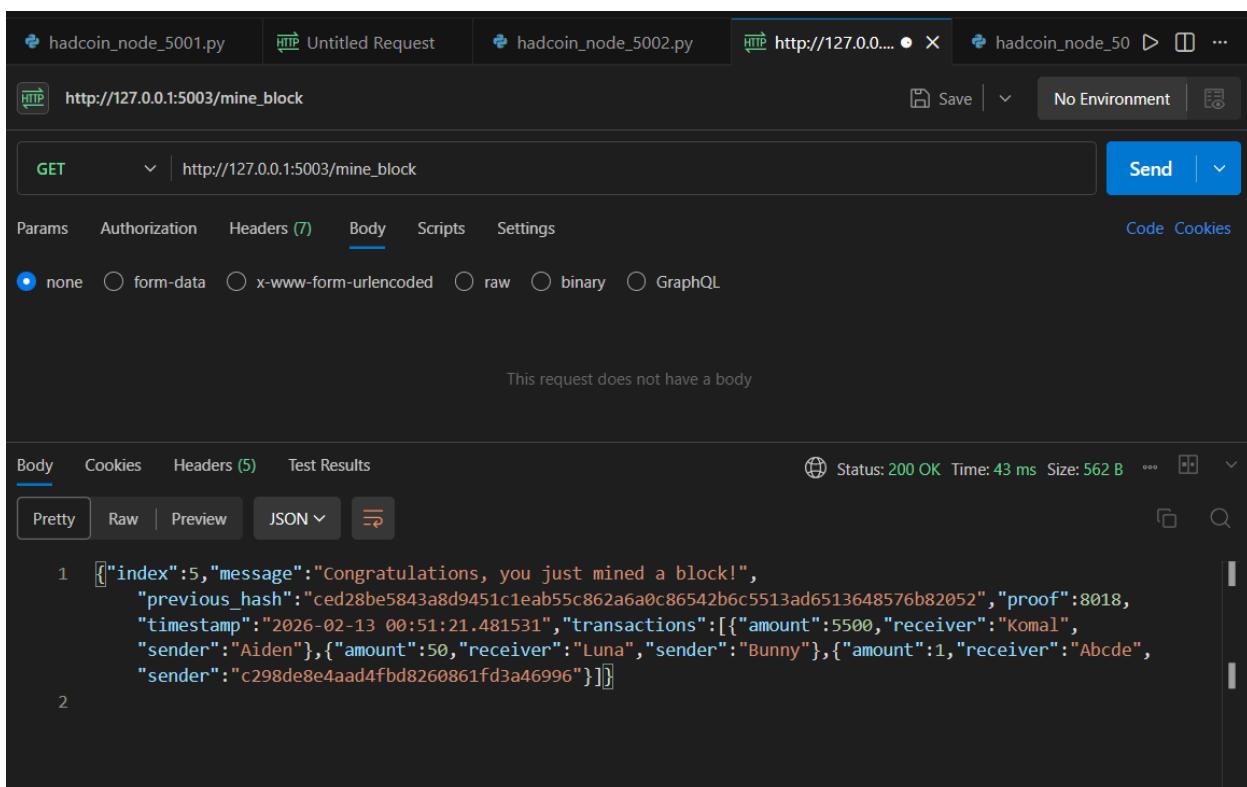
```

1  [
2   .. "sender": "Bunny",
3   .. "receiver": "Luna",
4   .. "amount": 50
5 ]
6

```

The response status is 201 Created, and the message is "This transaction will be added to Block 5".

Mine the block



The screenshot shows the Postman interface with a GET request to `http://127.0.0.1:5003/mine_block`. The response status is 200 OK, and the message is "Congratulations, you just mined a block!". The response body contains a block object:

```

1  [{"index":5,"message":"Congratulations, you just mined a block!",
  "previous_hash": "ced28be5843a8d9451c1eab55c862a6a0c86542b6c5513ad6513648576b82052",
  "proof":8018,
  "timestamp": "2026-02-13 00:51:21.481531", "transactions": [{"amount":5500,"receiver": "Komal",
  "sender": "Aiden"}, {"amount":50,"receiver": "Luna", "sender": "Bunny"}, {"amount":1,"receiver": "Abcde",
  "sender": "c298de8e4aad4fbd8260861fd3a46996"}]}
2

```

Now we have total 5 blocks on node 3 which is greater than node 2

```

1  [{"chain": [{"index": 1, "previous_hash": "0", "proof": 1, "timestamp": "2026-02-12 23:29:06.881988", "transactions": []}, {"index": 2, "previous_hash": "efdfba6a55693f005f0615c4418f34d7414f04b90ab25bf27a4f0a9986c434e7", "proof": 533, "timestamp": "2026-02-13 00:44:20.441888", "transactions": [{"amount": 2400, "receiver": "Jack", "sender": "Rama"}, {"amount": 200, "receiver": "Oggy", "sender": "Olivia"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fdb8260861fd3a46996"}]}, {"index": 3, "previous_hash": "75db327a0734acdb8d275f8867532706173bfd6c37197b60ea3b23633774450", "proof": 45293, "timestamp": "2026-02-13 00:46:16.239571", "transactions": [{"amount": 500, "receiver": "Henry", "sender": "Bob"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fdb8260861fd3a46996"}]}, {"index": 4, "previous_hash": "7f6ca82a7b54682138cef625f01e9e47bc93e764f8b28a63e24f86cc1cf85616", "proof": 21391, "timestamp": "2026-02-13 00:48:20.485850", "transactions": [{"amount": 100, "receiver": "Leon", "sender": "Robin"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fdb8260861fd3a46996"}]}, {"index": 5, "previous_hash": "ced28be5843a8d9451c1eab55c862a6a0c86542b6c5513ad6513648576b82052", "proof": 8018, "timestamp": "2026-02-13 00:51:21.481531", "transactions": [{"amount": 5500, "receiver": "Komal", "sender": "Aiden"}, {"amount": 50, "receiver": "Luna", "sender": "Bunny"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fdb8260861fd3a46996"}]}], "length": 5}
2

```

From node 1 I did not add anything

```

1  [{"chain": [{"index": 1, "previous_hash": "0", "proof": 1, "timestamp": "2026-02-12 23:28:08.835995", "transactions": []}], "length": 1}
2

```

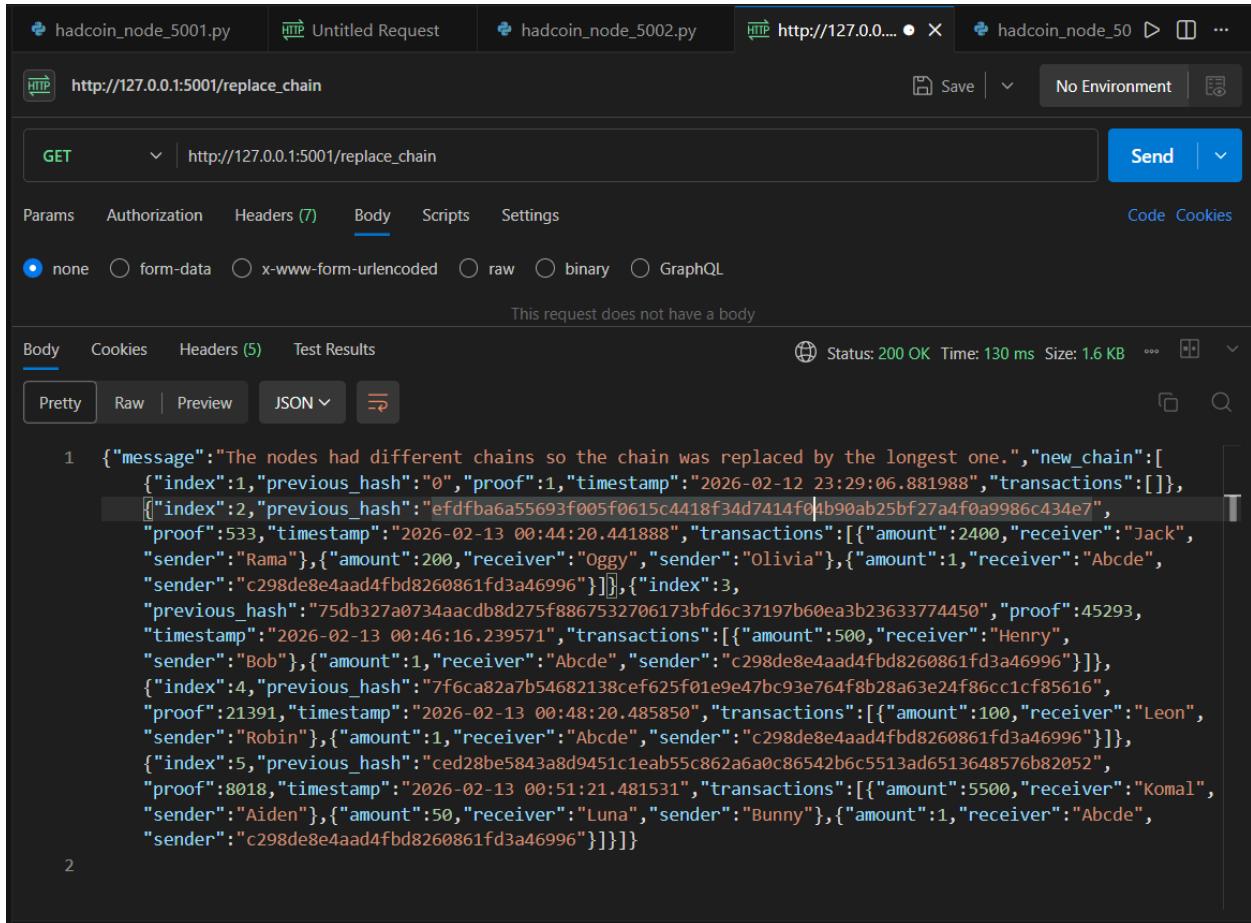
The terminal tab shows the following log output:

```

Press CTRL+C to quit
127.0.0.1 - - [12/Feb/2026 23:33:08] "GET /connect_node HTTP/1.1" 405 -
127.0.0.1 - - [12/Feb/2026 23:33:22] "POST /connect_node HTTP/1.1" 201 -
127.0.0.1 - - [12/Feb/2026 23:52:21] "GET /get%20chain HTTP/1.1" 404 -
127.0.0.1 - - [12/Feb/2026 23:52:31] "GET /get_chain HTTP/1.1" 200 -
127.0.0.1 - - [13/Feb/2026 00:04:12] "GET /get_chain HTTP/1.1" 200 -

```

replace_chain : As node 2 have two blocks and node 3 has five blocks so node replaced its chain with 5 blocks as it is the longest one



```

1  {"message": "The nodes had different chains so the chain was replaced by the longest one.", "new_chain": [
    {"index": 1, "previous_hash": "0", "proof": 1, "timestamp": "2026-02-12 23:29:06.881988", "transactions": []},
    [{"index": 2, "previous_hash": "efdfba6a55693f005f0615c4418f34d7414f04b90ab25bf27a4f0a9986c434e7", "proof": 533, "timestamp": "2026-02-13 00:44:00.441888", "transactions": [{"amount": 2400, "receiver": "Jack", "sender": "Rama"}, {"amount": 200, "receiver": "Oggy", "sender": "Olivia"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fdb8260861fd3a46996"}]}, {"index": 3, "previous_hash": "75db327a0734aacdb8d275f8867532706173bfd6c37197b60ea3b23633774450", "proof": 45293, "timestamp": "2026-02-13 00:46:16.239571", "transactions": [{"amount": 500, "receiver": "Henry", "sender": "Bob"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fdb8260861fd3a46996"}]}, {"index": 4, "previous_hash": "7f6ca82a7b54682138cef625f01e9e47bc93e764f8b28a63e24f86cc1cf85616", "proof": 21391, "timestamp": "2026-02-13 00:48:20.485850", "transactions": [{"amount": 100, "receiver": "Leon", "sender": "Robin"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fdb8260861fd3a46996"}]}, {"index": 5, "previous_hash": "ced28be5843a8d9451c1eab55c862a6a0c86542b6c5513ad6513648576b82052", "proof": 8018, "timestamp": "2026-02-13 00:51:21.481531", "transactions": [{"amount": 5500, "receiver": "Komal", "sender": "Aiden"}, {"amount": 50, "receiver": "Luna", "sender": "Bunny"}, {"amount": 1, "receiver": "Abcde", "sender": "c298de8e4aad4fdb8260861fd3a46996"}]}]
2

```

Conclusion :

In this experiment, a basic cryptocurrency was created using Python and the Flask framework. A blockchain was implemented with features like transactions, mining using proof of work, and chain validation. Multiple nodes were connected to simulate a decentralized network, and the longest chain consensus mechanism was applied. Transactions were also cleared after being added to a block, preventing duplication. This experiment helped in understanding the core concepts of blockchain, mining, and decentralized systems.